

VIRGINIA DEPARTMENT OF TRANSPORTATION

MOBILITY MANAGEMENT DIVISION

MEMORANDUM

GENERAL SUBJECT: Grounding	NUMBER: MM-312
	DATE: September 27, 2002
	SUPERSEDES: TE-302
SPECIFIC SUBJECT: Inspection and testing of grounding systems	SIGNATURE: <i>Ilona O. Kastenhofer</i>
DIRECTED TO: District Administrators	

This memorandum implements a revised policy for the inspection and testing of Department maintained grounding systems for traffic control devices.

Inspections and tests shall be accomplished in accordance with the attached requirements. Testing shall be completed within 1 year of issuance of this memorandum for all existing traffic control devices that have not been tested in accordance with the previous memorandum.

The District Administrator should develop a recurring schedule to inspect and test grounding systems for conformance to the requirements herein. The frequency of inspection shall be three (3) years except two (2) years shall be used in areas having a high sand content or where chemically enhanced grounding electrode systems have been used.

It is anticipated that the inspections and tests required herein will result in the determination of systems having inadequate equipment grounding systems (inadequately sized equipment grounding conductors, non-existent equipment grounding conductors, non-existent bonded metal conduit systems or failed equipment grounding systems). Decisions should be made on whether it is more feasible to correct the problem with the inadequate equipment grounding systems within the time constraints of this memorandum or whether to test the grounding electrode system and accomplish corrections to that system (if needed) to conform to the requirements herein. Locations, where corrections are not made to the equipment grounding conductor system to conform to the requirements of the latest edition of the *National Electrical Code (NEC)* during this inspection, shall be programmed for future correction unless the system is planned for removal and a determination is made that it would not be cost effective to make such corrections considering the amount of time until removal. The District Administrator shall develop a cost estimate and shall develop a plan for implementation based on current and future funding sources.

The testing and documentation requirements herein are only applicable for maintenance purposes; testing and documentation for new installations or for maintenance replacement of equipment shall be in accordance with the Road and Bridge Specifications.

DCF/MEM: def

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Mr. T. F. Chu
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Testing, Documentation and Corrective Action Requirements

1. Testing shall be accomplished with equipment specifically designed for such use and when the soil appears dry to ensure the accuracy of the readings.
2. Testing shall be accomplished by personnel experienced and/or trained to perform the work.
3. Testing to determine resistance to ground for the grounding electrode system shall be accomplished at the connection point of the grounding electrode conductor to the equipment while the conductor is connected to the grounding electrode(s). The grounding electrode conductor shall be disconnected from the equipment unless the testing equipment is specifically designed to provide test results for the grounding electrode system while not being affected by the conductor connection. Grounding electrode conductors shall be disconnected from grounding bushings during the test. When the grounding electrode conductor remains connected to the equipment during testing as allowed above, the equipment grounding conductor shall be disconnected to eliminate a parallel path to ground.
4. When new equipment grounding conductors are installed, they shall conform to the size requirements of the attached memorandum dated July 27, 2001 with the following exceptions and clarification:
 - a. For existing signalized intersections, spare conductors may be used as the equipment grounding conductors provided they conform and are installed in accordance with the requirements of the *NEC*.
 - b. For existing signalized intersections, equipment grounding conductors, sized in accordance with the requirements of the *NEC*, shall be used if such use eliminates the need to replace the conduit with a larger size due to conduit fill.
 - c. For all existing installations, continuous metal conduit may be used as the equipment grounding conductor provided grounding bushings are installed and bonded.
 - d. At span wire installations, the span wire may be used as the equipment grounding conductor provided electrical continuity exists as determined by a continuity test. If electrical continuity does not exist, a #8 equipment grounding conductor shall be attached to the span wire (prior to the connecting hardware at each pole) and the poles to ensure continuity of the equipment grounding path. Where glass strain insulators and/or saddle clamps exist, a #8 jumper shall be used to connect the separate span wires. Appropriate connectors shall be used to connect the #8 to the span wire. A continuity test shall be accomplished for verification.

5. Documentation of the testing shall be accomplished using the attached form for all new and recurring tests. Electronic versions of this form will be available on the Mobility Management Division's intranet. Modification of the form is allowed as long as the data shown as a minimum is being recorded. Documentation shall be maintained for the previous and current tests and a copy of the completed forms shall be sent to the State Mobility Manager.
6. Corrective action needed at each site to conform to the requirements of this memorandum shall be completed within ten (10) working days after determination of inadequacy unless otherwise approved by the District Administrator.
7. Corrective work shall be accomplished in accordance with the applicable sections of the latest versions of the *Road and Bridge Specifications*, *Road and Bridge Standards* and *NEC* Article 250.

Inspection and Testing at Service Entrance Equipment

Test the grounding electrode system to determine if the resistance to ground is 25 ohms or less:

1. If 25 ohms or less, an augmentation grounding electrode having at least 8 feet contact with the soil shall be installed (if not already existing) at least 8 feet from all other grounding electrodes and connected in parallel with the primary grounding electrode.
2. If more than 25 ohms, then additional grounding steps or methods, including but not limited to, deep earth grounding and a chemically enhanced grounding electrode system shall be taken to achieve 25 ohms or less. Upon achieving 25 ohms or less, the requirements of 1. above shall be accomplished. When considering the use of chemically enhanced grounding electrode systems, environmental approval from the District Environmental Engineer shall be obtained for the specific system prior to its use.
3. If the test is being accomplished under the recurring schedule as required herein, then the test result shall be reviewed against the previous completed test to determine if any action, such as checking connections for problems, etc. is needed.

Inspection and Testing at Control Cabinets Housing Electrical/Electronic Equipment (e.g., controller cabinets, lighting control centers for roadway, parking lot and sign lighting, etc.), Structures (other than the service entrance structure), Junction Boxes, Manholes, Etc.

Determine if an equipment grounding conductor exists between the service entrance equipment and the control cabinet and at the structures, junction boxes and manholes:

1. If an equipment grounding conductor exists, then the following shall be accomplished:
 - a. If not electrically connected, necessary corrections shall be performed.
 - b. Determine if the conductor is sized properly in accordance with the requirements of the *NEC*:
 - i. If sized properly, no action is needed.
 - ii. If not sized properly, document the information for future correction unless replaced with the proper size conductor.
 - c. Determine if a grounding electrode system exists at the cabinets, structures, junction boxes and manholes:
 - i. If not existing but required by the *NEC* or the Virginia Road and Bridge Standards for that location, one shall be installed. Since these are supplementary grounding electrodes, only one grounding electrode need be installed and connected to the equipment grounding conductor to form a system. There shall be no testing required since there is no requirement in the *NEC* for the maximum resistance to ground for supplementary grounding electrodes.
 - ii. If existing, no action is needed.
2. If an equipment grounding conductor does not exist, but is required by the *NEC*, the following shall be accomplished unless an equipment grounding conductor is installed. If an equipment grounding conductor is installed, the requirements of 1c. shall then apply:
 - a. Test the grounding electrode system to determine if the resistance to ground is 25 ohms or less:
 - i. If 25 ohms or less, an augmentation grounding electrode having at least 8 feet contact with the soil shall be installed (if not already existing) at least 8 feet from all other grounding electrodes and connected in parallel with the primary grounding electrode.
 - ii. If more than 25 ohms, then additional grounding steps or methods, including but not limited to, deep earth grounding and a chemically enhanced grounding electrode system shall be taken to achieve 25 ohms or less. Upon achieving 25 ohms or less, the requirements of 2.a.i. above shall be accomplished. When considering the use of chemically enhanced grounding electrode systems, environmental approval from the District Environmental Engineer shall be obtained for the specific system prior to its use.
 - iii. If the grounding electrode and grounding electrode conductor do not exist, such shall be installed and the test accomplished except for non-metallic junction boxes (polymer concrete, etc.) where the insulation rating of all power cables within the box is 600 volts or greater and no splicing is being accomplished for those power cables.

**COMMONWEALTH OF VIRGINIA
VIRGINIA DEPARTMENT OF TRANSPORTATION
GROUNDING SYSTEM INSPECTION REPORT**

DISTRICT _____ DATE _____ TEST PERFORMED BY _____

[illegible]

(Print Name of VDOT Representative Present During Testing If Tests Conducted By Contractor)

COUNTY	ROUTE	GENERAL DESCRIPTION/LOCATION
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EQUIPMENT USED	EQUIPMENT CALIBRATION DATE

[illegible]



COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION

1401 EAST BROAD STREET
RICHMOND, 23219-2000

July 27, 2001

CHARLES D. NOTTINGHAM
COMMISSIONER

ILONA O. KASTENHOFER
STATE TRAFFIC ENGINEER

Equipment Grounding Conductors For Grounding Raceway and Equipment

MEMORANDUM

TO – District Traffic Engineers

The intent of this memorandum is to provide the latest information concerning equipment grounding conductors for grounding raceways and equipment and replaces all such information previously indicated in Mr. J. L. Butner's memorandum dated April 21, 1992. It should be noted that in the previous memorandum that the terminology "system bond wire" was used; however, to be consistent with the terminology used in the National Electrical Code (NEC), the terminology "equipment grounding conductors" will be used in this memorandum.

Since 1992, the equipment grounding conductor sizes have been determined by the plan designers and shown on the plans. This prevented the Department from relying on the Contractor to assure the correct equipment grounding conductor size was selected and allowed the field personnel responsible for inspections to know the exact size requirements at each location. We still believe this to be the best method and have no plans to change that at this time. However, based on the NEC, we have determined that we need to change the calculation method for sizing of the equipment grounding conductors used for lighting applications and other applications where the power conductor size has been adjusted to compensate for voltage drop. This change in the calculation method will cause an increase in the size of the equipment grounding conductor in most installations. While the NEC provides the calculation method concerning this, it has been determined by working through multiple examples of typical installations that the equipment grounding conductor will be increased to be the same size as the power conductor. Therefore, to eliminate the expense of accomplishing the calculations, it has been decided to require the equipment grounding conductor to be the same size as the power conductor for lighting applications and other applications where the power conductor size has been adjusted to compensate for voltage drop.

In order for everyone to know what is required, we have attached a sheet entitled Equipment Grounding Conductor Sizes for Grounding Raceways and Equipment. This attachment will provide the direction to the plan designers so they will know what is required on the plans along with the proper equipment grounding conductor size.


District Traffic Engineers
July 27, 2001
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As it has been in the past, the cost of the equipment grounding conductor is included in the cost of the conduit, therefore no pay item will be needed. The only exception to this would be if you are installing equipment grounding conductors in existing conduits; in those instances, you will need to have a separate pay item for the equipment grounding conductor or you will need to indicate that the cost is included in other appropriate pay items.

This revised method shall be used on all projects that bids have not been received provided you can obtain approval to make the changes from Construction Division for those already advertised. This method will in most instances increase the equipment grounding conductor size so it will also be necessary to verify that the conduit size is capable of handling this increase.

In existing installations, the equipment grounding conductor should be adjusted to conform to these requirements for those conduits where conductor cables are being replaced or additional cables are being installed within such conduits. As indicated before, you will need to ensure that the conduit size is capable of handling the increase. When not, replacement of the conduit will be required.

If there are any questions, please contact Mr. Mansour Mahanoozadeh at (804) 786-7983 or via email at mahban_mei@vdot.state.va.us.


I. O. Kastenhofer
State Traffic Engineer

DCF/df
Attachment

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EQUIPMENT GROUNDING CONDUCTOR SIZES FOR GROUNDING RACEWAYS AND EQUIPMENT

BACKGROUND

The method of determining the equipment grounding conductor size for grounding raceways and equipment as shown herein will provide a size of equipment grounding conductor that equals or exceeds Article 250 of the NEC.

WHEN ARE EQUIPMENT GROUNDING CONDUCTORS REQUIRED

Equipment grounding conductors are only required in non-metallic conduits in accordance with Article 250 of the NEC. The NEC **does not require** that equipment grounding conductors be installed in non-metallic conduits when the line voltage of conductors is less than fifty (50) volts. (See latest version of the NEC for details)

Conductors such as loop lead-ins, pedestrian push button cable, DC interconnect cable, video detection coaxial cable, TMS communication cable, etc. have a line voltage of all conductors of less than fifty volts and therefore will not require a equipment grounding conductor.

EQUIPMENT GROUNDING CONDUCTOR SIZE

Determination of the equipment grounding conductor size shall be in accordance with the following:

- ❑ Traffic Signals – All traffic signals will require 1#8 AWG conductor in non-metallic conduits for grounding raceways and equipment.
- ❑ Lighting Systems (Or Other Systems Where The Power Conductor Size Has Been Adjusted To Compensate For Voltage Drop) – Equipment grounding conductor shall be the same size as the largest power conductor within the non-metallic conduit.

EXAMPLE PLAN NOTE

Since the contractor normally has the option of providing metal conduits where we do not specifically state non-metallic conduits, the following note is recommended for installation on the plans:

Equipment grounding conductor shown on plans is required only if the conduit is non-metallic.

EXAMPLE PLAN LABELING FOR CONDUITS

- ❑ Traffic Signals
 - 2" Conduit
 - 4-7c
 - 2-2c(s)
 - 1#8 AWG Equipment Grounding Conductor
- ❑ Lighting Systems
 - 2"-3#2 & 1#2 Equipment Grounding Conductor